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Check List
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LISTS OF SPECIES

Checklist of Angiosperms from the Pedra Furada Municipal Park, northeastern Brazil

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ABSTRACT: Due to the scarcity of data on the biotic diversity of rocky outcrops, this work presents the checklist of flowering plants (angiosperms) from the Pedra Furada Municipal Park (8°34'30" S, 36°52'45" W; 3 ha), in the northeast region of Brazil. Random samples were carried out from Jan-Dec 1998 and 2004-2009, totaling 125 species and 44 families. Fabaceae (14 spp.), Euphorbiaceae (13), Convolvulaceae (10), Cyperaceae (7), Apocynaceae (6), Cactaceae (6) and Bromeliaceae (5) comprise about 50% of the species. Due to variations in the rock slope and soil depth, the plants are distributed throughout three environments: slopes (65 species), plateaus (39) and escarpments (5), with some of them occurring both in plateaus and slopes (17). Among the species of the park, some are endemic to the caatinga (*e.g. Piptadenia stipulacea* and *Maytenus rigida*), and others are restricted to rocky outcrop areas (*Ameroglossum pernambucense* and *Pithecoseris pacourinoides*), providing evidence of the park's relevance to the preservation of the local flora.

INTRODUCTION

The Brazilian semi-arid region comprises about 50% of the northeast region and is commonly associated with steppe-savanna vegetation, known as *caatinga* (Veloso *et al.* 1991). Besides the *caatinga*, other vegetation formations resulting from mesoclimatic and edaphic variations, such as montane and plateau forest vegetation, occur within its area (Vasconcelos-Sobrinho 1949; Andrade-Lima 1981; Ab'Saber 2003). The rocky outcrops, vegetation formations very common in the semi-arid landscape, are included among these (Velloso *et al.* 2002; Seabra 2005), and their dystrophic substrate significantly affects the composition and structure of the communities (Murdy *et al.* 1970; Phillips 1981; Gröger and Barthlott 1996; Kluge and Brufelt 2000; Szarzynski 2000). Moreover, the vegetation is subjected to different climatic conditions from the biome in which it is inserted, such as wide temperature fluctuation, low relative air humidity, high solar radiation and intense winds (Murdy *et al.* 1970; Phillips 1981; Gröger and Barthlott 1996; Kluge and Brufelt 2000; Szarzynski 2000).

The Pedra Furada Municipal Park is formed by a group of small and medium-size granite rock outcrops, and the Pedra Furada, which is of larger dimensions. This group presents an area of approximately 3 hectares, with an altitude between 596 and 723 meters, located approximately 200 km from the Atlantic coast (8°34'30" S, 36°52'45" W), in the city of Venturosa, in the semi-arid region of the state of Pernambuco (Figures 1 and 2). The location was established as a preservation unit because it is an archaeological site with prehistoric records of the Agreste Tradition (Aguiar 1986) which, added to its scenic beauty, places it on the route for ecological tourism of the region.

Although protected, checklists are nonexistent for the park. Furthermore, while most of the studies of rock outcrop areas in the Brazilian northeast have been conducted in the semi-arid (*e.g.* França *et al.* 1997; 2005; 2006; Gomes and Alves 2009; 2010), there have been too few to understand the diversity of these environments in the region (Martinelli 2007). Basic knowledge, such as the relation with other types of *caatinga* vegetation, remains unclear (see Gomes and Alves 2009). To this end, the present study aimed to survey the angiosperm species

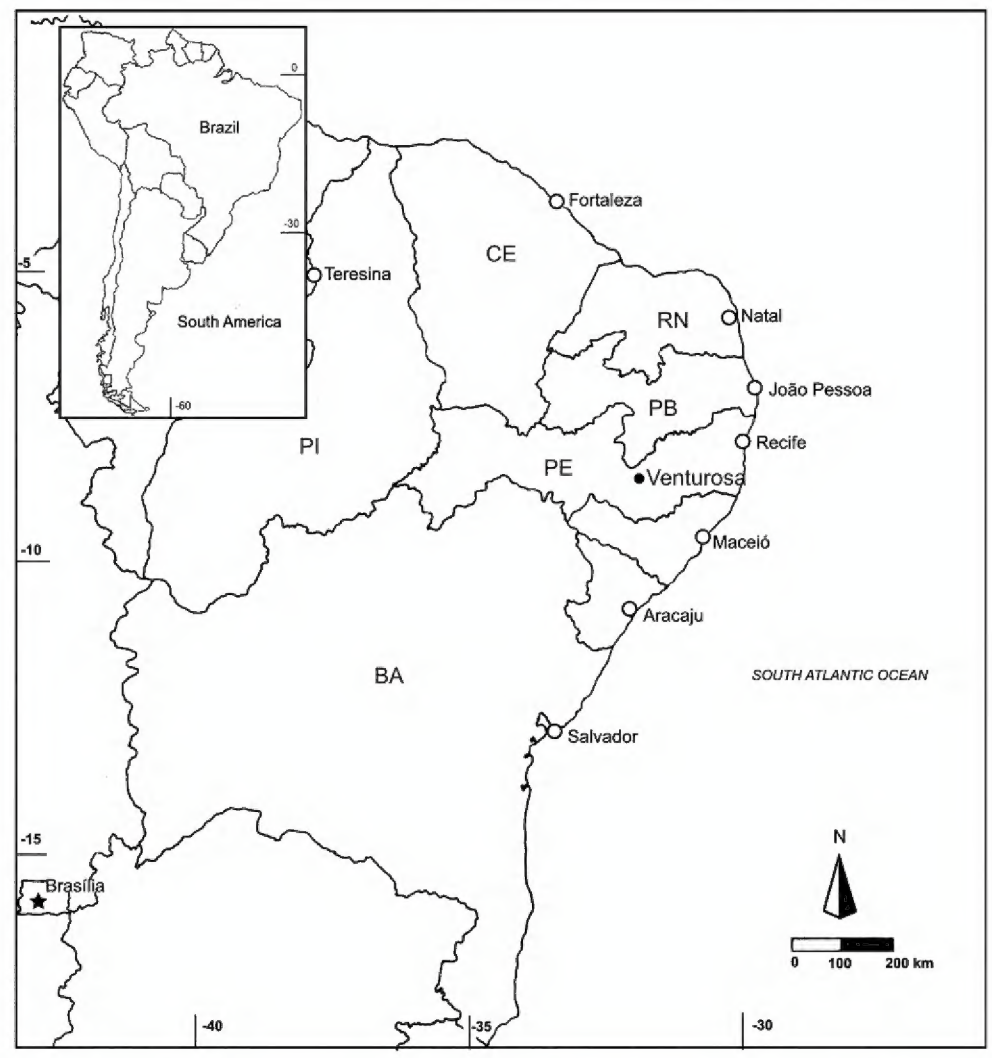

FIGURE 1. Map of the northeast region, indicating the location of the city of Venturosa, where the study area, the Pedra Furada Municipal Park, is located.

present in the Pedra Furada Municipal Park, in order to contribute to a better phytogeographic characterization of the rocky outcrops in the Brazilian northeast.

Material and Methods

Area of study

The Pedra Furada Municipal Park is located in the Agreste mesoregion and in the Vale do Ipanema microregion (Beltrão *et al.* 2005). With regards to the geomorphology, it is located in the western portion of the Borborema Plateau, one of the main landscape units of the Brazilian Northeast, formed by massifs or irregular and folded blocks, dating from the Precambrian era (Morais-Neto and Alkmin 2001; Jatobá 2003).

The climate is characterized by marked irregularity in rainfall distribution, but the conditions are milder than those found in the inter-plateau depressions (Veloso *et al.* 1991). The average annual precipitation is 664.7mm, with 6-8 dry months (0-49mm) and 4-6 rainy months (88-193mm), and the average annual temperature is 27ºC, with amplitude ranging from 18 to 31°C (ITEP 2008).

The *caatinga* is the predominant vegetation along the trails of the park. The other areas correspond to the rocky outcrop areas which present rupicolous vegetation, predominantly shrub and herbaceous vegetation. The largest rocky outcrop of the area, called Pedra Furada, has three types of habitats – escarpments, plateaus and slopes – which are differentiated primarily by the rock slope and soil depth. The escarpments are characterized by shallow or nonexistent soil and by marked inclination. These steep sections alternate with plateaus, where the soil is still shallow, however of a sufficient depth to support a more shrubby vegetation. On the other hand, the slopes refer to the locations at the base of the Pedra Furada, where the largest accumulation of soil occurs and the vegetation is denser and dominated by shrubby-arboreal species.

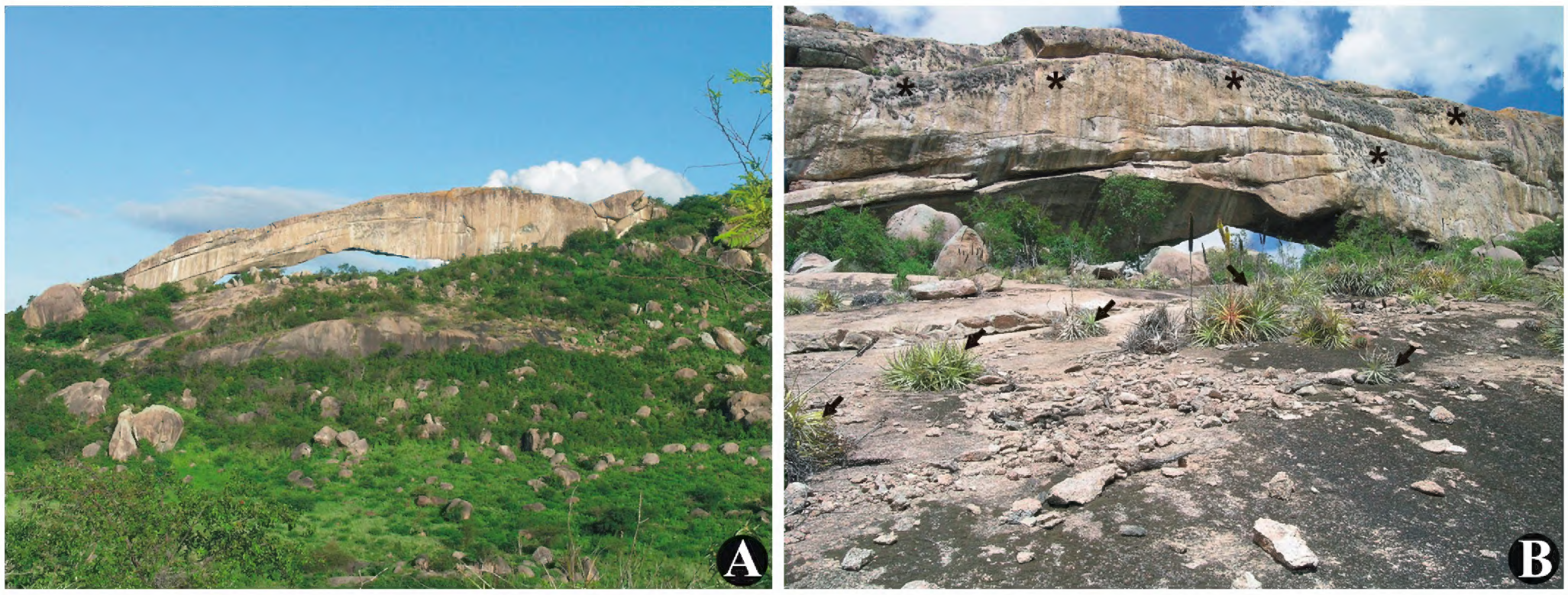

Figure 2. Overview of the Pedra Furada Municipal Park: A. some of the rocky outcrops in the study area. Pedra Furada is the largest outcrop and presents an arch-shaped top, which presents shrubby *caatinga* vegetation at its base; B. one of Pedra Furada's plateaus. In the foreground, *Encholirium spectabile* (Bromeliaceae) vegetation islands (narrows). Above and background, *Tillandsia* species carpets (Bromeliaceae) covering the steep sections of the rock (asterisks).

Sample collections

Monthly samples of the angiosperm flora were conducted within the period from January to December 1998, and semiannual samples were carried out from 2004 to 2009, during the dry and rainy seasons. The collections were carried out randomly, including all the types of phyto-physiognomies occurring within the area, and were more intensive on the rocky outcrop that gives its name to the park. The material was processed according to the usual methodology in botanical studies (Mori *et al.* 1985) and input into the PEUFR and UFP herbaria (see Index Herbariorum at http://sweetgum.nybg.org/ih).

The species identifications were carried out by consulting the UFP, PEUFR, IPA, HUEFS, SP and SPF herbarium collections (see Index Herbariorum in http://sweetgum.nybg.org/ih), specialized bibliography and specialists. The resulting floristic list is consistent with the APG III (2009) proposed phylogenetic classification.

Results and Discussion

A total of 125 species were found, distributed in 44 families, with Fabaceae (14 species), Euphorbiaceae (13 spp.), Convolvulaceae (10 spp.), Cyperaceae (7 spp.), Apocynaceae (6 spp.), Cactaceae (6 spp.) and Bromeliaceae (5 spp.) being the richest families, comprising approximately 50% of the species (Table 1; see some species in Figure 3). Several studies have shown that Fabaceae has higher richness within rock outcrop areas in the northeast region of Brazil (França *et al.* 1997; Araújo *et al.* 2008; Porto *et al.* 2008; Gomes and Alves 2009), which differs from those of the southeast region (Oliveira *et al.* 2004; Oliveira and Godoy 2007). This is the most important taxonomic group in *caatinga* vegetation (Queiroz 2002) and the richest one in the present study, with species belonging to diverse genera. *Piptadenia stipulacea*, *Senna martiana* and *Poincianella gardneriana*, endemic to the *caatinga* (Giulietti *et al.* 2002), and *Acacia bahiensis*, *Mimosa ophthalmocentra* and *Parapiptadenia zehntneri*, typical species from this type of vegetation (Queiroz 2009), are generally distributed in deeper soils within the study site.

Similarly, Euphorbiaceae is common in the rocky outcrops of the region, however with predominance of the species belonging to the genus *Croton* (França *et al.* 1997; 2005; 2006; Carneiro-Torres *et al.* 2002; Gomes and Alves 2009; 2010), represented by *Croton* cf. *gardnerianus*,

Croton micans and *Croton heliotropiifolius*. *Jatropha molissima*, *Jatropha ribifolia* and *Manihot epruinosa*, three other species of the family that occur in the park, are also considered endemic to the *caatinga*, which is also true for the species of Cactaceae *Pilosocereus pachycladus* ssp. *pernambucoensis* and *Melocactus oreas* (Giulietti *et al.* 2002; Taylor and Zappi 2002) which were also found in the park. In addition to these, another ten species from various families are also considered endemic to the *caatinga*: *Cynophalla flexuosa*, *Commiphora leptophloes*, *Cordia leucocephala* (Figure 3A), *Encholirium spectabile*, *Herissantia tiubae*, *Ipomoea brasiliana*, *Lippia gracilis*, *Maytenus rigida*, *Sida galheirensis* and *Spondias tuberosa* (Figure 3B) (Giulietti *et al.* 2002).

Although a relationship exists between the vegetation of the outcrop and the surrounding areas, the outstanding occurrence of Bromeliaceae is in accordance with the floristic composition of Brazilian rock outcrops (see Caiafa and Silva 2007; Ribeiro *et al.* 2007). Despite the absence of a systematic evaluation, *Encholirium spectabile* and *Tillandsia streptocarpa* visually appear to be the most abundant species within the study area in terms of vegetation structure, with *E. spectabile* very important in Northeastern Brazilian outcrops (França *et al.* 1997; 2005; 2006; Porto *et al.* 2008). Cyperaceae, one of the richest families within the area, is also typical from outcrops, however on a pantropical scale (Barthlott *et al.* 1993; Ibisch *et al.* 1995), including those from the southeast (*e.g.* Ribeiro *et al.* 2007) and northeast regions of Brazil (Porto *et al.* 2008; Gomes and Alves 2009). Despite the fact that Velloziaceae is equally common in rocky outcrops (*e.g.* Porembski *et al.* 1997; Oliveira *et al.* 2004; Oliveira and Godoy 2007), it does not present significant richness in the northeast region. At the Pedra Furada Municipal Park, it is represented by a single species, *Nanuza plicata*, whose population is restricted to a plateau in the middle section of Pedra Furada.

Convolvulaceae does not characterize rocky outcrops and its species are found mainly in the sections of *caatinga* vegetation of the park. On the other hand, Apocynaceae, the fifth richest family in this study, is one of the main taxa of the vegetation of rocky environments in South America (see Barthlott and Porembski 2000a). Its species stand out in the physiognomy of Pedra Furada, especially *Ditassa hastata*. Another representative species of the park, *Calotropis procera*, is native to Asia and occurs as an invasive species in the *caatinga*. It is well adapted to semi-arid conditions (Fontella-Parreira 1980) and represents a risk to the native flora due to competition.

Considering the distribution of species within the three environments of Pedra Furada, the following data were registered: 65 species occurred in the slope sections, 39 in the plateaus, and 17 were registered both in the plateaus and the slopes (Table 1). Only five species colonize the escarpments within the areas of study, and four of them belong to the genus *Tillandsia,* which are distributed on steep sections, covering the rock as a "carpet". On the slope, where there is a higher accumulation of organic material in the soil, the vegetation is dominated by arboreal-shrub species, such as *Cynophalla flexuosa*, *Erythrina velutina*, *Luetzelburgia auriculata*, *Spondias tuberosa,* and *Ziziphus joazeiro*, typical of the arboreal *caatinga* (Andrade-Lima 1981). On the other hand, on the plateaus, individuals from different species are not distributed uniformly on the rock surface; they are grouped in vegetation islands.

Cyrtopodium intermedium, *Gonolobus cearensis* (Figure 3C), *Matelea maritima*, *Nanuza plicata*, *Nicotiana glauca* and *Pithecoseris pacourinoides* (Figure 3D) were found exclusively on plateaus in the medial portion of the outcrop, and *Ameroglossum pernambucense* (Figure 3E) and *Callisthene microphyla* are distributed exclusively on the top plateaus. This variation of the floristic composition with altitude has already been observed before in mountain environments in the Northeast region (Agra *et al.* 2004; Gomes and Alves 2009). The populations of *Ditassa hastata* also showed limited distribution, however in places with strong exposure to the light, being absent in the sections where the solar incidence is less intense. However, other species occur throughout the area of study, such as *Cnidoscolus loefgrenii*, *Melochia tomentosa* (Figure 3F) and *Sida galheirensis*, these latter two being widely distributed throughout the *caatinga*, especially in areas with some human interference (Amorim *et al.* 2009).

While most of the species mentioned above are reported from the *caatinga* surrounding these outcrops, there are two species (*Ameroglossum pernambucense* - Scrophulariaceae and *Pithecoseris pacourinoides* - Asteraceae, Figures 3D-E) restricted to rocky environments of the northeast. Rare and endemic species are common in rocky outcrops (Ibisch *et al.* 1995; Seine at al. 2000), possibly because edaphic and climatic isolation promotes speciation (Barthlott and Porembski 2000b). Rocky outcrops of the southeastern Brazilian Atlantic Forest present a higher number of endemic species, and have a flora with greater similarity to *restinga* when compared to the immediately surrounding forest matrix (see Meirelles *et al.* 1999; Porembski 2007; Ribeiro *et al.* 2007). In relation to outcrops inserted in the *cerrado* matrix, Oliveira and Godoy (2007) found several common species to the surrounding area, as observed here. Thus, the degree of shared species between rocky outcrops and the surrounding vegetation seems to be related to the environmental similarities between these two environments.

Finally, this study showed that the Pedra Furada Municipal Park presents relevance to the preservation of the local flora, taking into account the fact that its plant diversity includes both endemic species of the *caatinga* and species restricted to rock outcrops. We also expect that the information contained in the present study will be useful to the development of a management plan for the park.

Table 1. List of the species, their respective families and voucher specimens found in the Pedra Furada Municipal Park, semi-arid region of northeastern Brazil; * species observed within the study site, but not collected due to the difficult access to their individuals; † species registered in digital image database (Figure 3G).

FAMILY	SPECIES	ENVIRONMENT	VOUCHER
Acanthaceae	*Ruellia asperula* (Mart. & Ness) Lindau	P	K. C. 187
Amaranthaceae	*Alternanthera brasiliana* (L.) Kuntze	P	K. C. 37
Anacardiaceae	*Myracrodruon urundeuva* Allemão	S	K. C. 154
	Spondias tuberosa Arruda	S	Y. M. 28
Apocynaceae	*Aspidosperma pyrifolium* Mart.	S	K. C.180
	Calotropis procera (Aiton) W.T.Aiton	S	K. M. 70
	Ditassa glaziovii E. Fourn	P	K. C. 80
	Ditassa hastata Decne.	P	P. G. 825
	Gonolobus cearensis Malme	P	P. G. 819
	Matelea nigra (Decae.) Morillo & Fontella	P	P. G. 821
Araceae	*Philodendron bipinnatifidum* Schott ex Endl.	E	*†
Aristolochiaceae	*Aristolochia* sp.	S	Y. M. 26
Asteraceae	*Ageratum conyzoides* L.	P	P. G. 398
	Pithecoseris pacourinoides Mart. ex DC.	P	P. G. 393
	Vernonia chalybaea Mart. ex DC.	P	P. G. 400
Bignoniaceae	*Pithecoctenium crucigerum* (L.) A. Gentry	S	P. G. 827
	Tabebuia aurea (Silva Manso) Benth. & Hook.f. ex S.Moore	S	K. C.179
Boraginaceae	*Cordia globosa* (Jacq.) Kunth	S	K. C. 30
	Cordia leucocephala Moric.	S	K. C.131
	Cordia verbenacea DC.	S	K. C. 104
Bromeliaceae	*Encholirium spectabile* Mart. ex Schult. & Schult.f.	P	K. C. 170
	Tillandsia didisticha (E. Morren) Baker	E	P. G. 404
	Tillandsia loliacea Mart. ex Schult. & Schult.f.	E	K. C. 106
	Tillandsia recurvata (L.) L.	E	K. C. 79
	Tillandsia streptocarpa Baker	E	K. C. 121
Burseraceae	*Commiphora leptophloeos* (Mart.) J.B. Gillett	S	K. C. 42
Cactaceae	*Cereus jamacaru* DC.	P, S	K. C. 171
	Harrisia adscendens (Gürke) Britton & Rose	S	K. C. 169
	Melocactus oreas Miq.	P, S	K. C. 62
	Pilosocereus gounellei (F.A.C.Weber) Byles & G.D.Rowley	P	K. C. 172
	Pilosocereus pachycladus Ritter subsp. *pernambucoensis* (F.Ritter) Zappi	S, P	K. C. 60
	Tacinga palmadora (Britton and Rose) N.P. Taylor and Stuppy	S	K. C. 174
Capparaceae	*Cynophalla flexuosa* (L.) J.Presl.	S	K. C. 12
	Cynophalla hastata (Jacq.) J.Presl.	S	K. C. 192
	Hemiscola diffusa (Banks ex DC.) Iltis.	P	P. G. 403
Celastraceae	*Maytenus rigida* Mart.	S, P	K. C. 11
Commelinaceae	*Commelina obliqua* Vahl	P	K. C. 99
Convolvulaceae	*Ipomoea acuminata* (Vahl) Roem. & Schult.	S	A. R. 08
	Ipomoea alba L.	S	A. R. 15
	Ipomoea brasiliana Meisn.	S	A. R. 06
	Ipomoea nil (L.) Roth	S	P. G. 385
	Ipomoea purpurea (L.) Roth	S	A. R. 02
	Ipomoea rosea Choisy	S	P. G. 387
	Ipomoea subincana Meisn.	S	A. R. 07
	Jacquemontia evolvuloides Meisn.	S, P	P. G. 386
	Merremia aegyptia (L.) Urb.	S	A. R. 04
	Operculina macrocarpa (L.) Urb.	S, P	A. R. 23

Table 1. ***Continued.***

FAMILY	SPECIES	ENVIRONMENT	VOUCHER
Cucurbitaceae	*Momordica charantia* L.	S	K. C. 86
Cyperaceae	*Bulbostylis scabra* (J.Presl & C.Presl) C.B.Clarke	P	P. G. 818
	Cyperus aggregatus (Willd.) Endl.	P	S. M. 102
	Cyperus schomburgkianus Ness	P	P. G. 822
	Cyperus uncinulatus Schrad. ex Nees	P	S. M. 80
	Lipocarpha micrantha (Vahl) G.C.Tucker	P	S. M. 75
	Pycreus capillifolius (A.Rich.) C.B.Clarke	P	S. M. 100
	Rhynchospora contracta (Nees) J.Raynal	S	S. M. 77
Dioscoreaceae	*Dioscorea ovata* Vell.	S	K. C. 135
	Dioscorea piperifolia Humb. & Bonpl. ex Willd.	S	K. C. 193
Euphorbiaceae	*Acalypha multicaulis* Müll.Arg.	S	P. G. 402
	Astraea lobata (L.) Klotzsch	S, P	K. C. 70
	Bernardia sidoides (Klotzsch) Müll.Arg.	S, P	K. C. 132
	Cnidoscolus loefgrenii (Pax & K.Hoffm.) Pax & K.Hoffm.	S, P	K. C. 88
	Croton cf. *gardnerianus* Baill.	S	K. C. 107
	Croton micans Sw.	S, P	K. C. 109
	Croton heliotropiifolius Kunth	S	K. C. 53
	Euphorbia hyssopifolia L.	S	K. C. 128
	Euphorbia serpens Kunth	S	K. C. 130
	Jatropha mollissima (Pohl) Baill.	S, P	P. G. 824
	Jatropha ribifolia (Pohl) Baill.	S, P	K. C. 132a
	Manihot epruinosa Pax & K.Hoffm.	S	K. C. 25
	Tragia volubilis L.	S	P. G. 399
Fabaceae	*Acacia bahiensis* Benth	S	K. C. 140
	Anadenanthera colubrina (Vell.) Brenan	S, P	K. C. 82
	Bauhinia cheilantha (Bong.) Steud.	S	K. C. 181
	Erythrina velutina Willd.	S	K. C. 167
	Indigofera suffruticosa Mill.	S	K. C. 221
	Libidibia ferrea (Mart. ex Tul.) L.P.Queiroz var. *ferrea*	S	K. C. 72
	Luetzelburgia auriculata (Allemão) Ducke	S	K. C. 185
	Mimosa ophthalmocentra Mart. ex Benth.	S	K. C. 189
	Mimosa cf. *tenuiflora* (Willd.) Poir.	S	K. C. 117
	Parapiptadenia zehntneri (Harms) M.P.M. de Lima & H.C. de Lima	S	K. C. 165
	Parkinsonia aculeata L.	S	K. C. 183
	Piptadenia stipulacea (Benth.) Ducke	S	P. G. 831
	Poincianella gardneriana (Benth.) L.P.Queiroz	S	K. C. 186
	Senna martiana (Benth.) H.S. Irwin & Barneby	S	K. C. 223
Lamiaceae	*Hyptis* aff. *fruticosa* Salzm. ex Benth.	S, P	K. C. 160
Loasaceae	*Aosa rupestris* (Gardner) Weigend	P	P. G. 391
Malpighiaceae	*Banisteriopsis* sp.	S	K. C. 153
	Galphimia brasiliensis (L.) A. Juss	S	K. C. 101
	Heteropterys tricanthera A. Juss.	S	P. G. 830
	Mascagnia sp.	S	K. C. 02
Malvaceae	*Helicteres* sp.	P	*
	Herissantia tiubae (K. Schum.) Brizicki	S	P. G. 394
	Melochia tomentosa L.	S	K. C. 78
	Sida galheirensis Ulbr.	S	K. C. 71
Molluginaceae	*Mollugo verticillata* L.	P	P. G. 828

Table 1. ***Continued.***

FAMILY	SPECIES	ENVIRONMENT	VOUCHER
Myrtaceae	*Campomanesia aromatica* (Aubl.) Griseb.	S	K. C. 111
	Campomanesia eugenioides var. desertorum (DC.) Landrum	S	BSA 640
Nyctaginaceae	*Guapira laxiflora* (Choisy) Lundell	S	K. C. 39
Orchidaceae	*Cyrtopodium intermedium* Brade	P	K. C. 137
Phytolacaceae	*Microtea paniculata* Moq.	S	K. C. 133
Plumbaginaceae	*Plumbago scandens* L.	S	K. C. 100
Poaceae	*Rhynchelytrum repens* (Willd.) C.E. Hubb.	S, P	P. G. 392
	Tragus berteronianus Schult.	S, P	K. C. 127
Portulacaceae	*Portulaca elatior* Mart. ex Rorhb.	P	P. G. 390
	Portulaca cf. *hirsutissima* Cambess	P	P. G. 405
Rhamnaceae	*Rhamnidium molle* Reissek	S	K. C. 66
	Ziziphus joazeiro Mart.	S	Y. M. 30
Rubiaceae	*Cordiera rigida* (K.Schum.) Kuntze	P	K. C. 143
	Guettarda platypoda DC.	P	P. G. 817
Santalaceae	*Phoradendron piauhyanum* Trel.	S	K. C. 191
Sapindaceae	*Cardiospermum corindum* L.	P	K. C. 46
	Cardiospermum oliveirae Ferrucci	S	K. C. 155
	Serjania glabrata Kunth	S, P	K. C. 182
Scrophulariaceae	*Ameroglossum pernambucense* Fischer, Vogel & Lopes	P	P. G. 397
Solanaceae	*Nicotiana glauca* Graham	P	P. G. 399a
	Solanum paniculatum L.	P	K. C. 184
	Solanum thomasiifolium Sendtn.	P	K. C. 55
	Solanum sp.	P	K. C. 91
Turneraceae	*Turnera ulmifolia* L.	P	K. C. 84
Velloziaceae	*Nanuza plicata* (Mart.) L.B.Sm. & Ayensu	P	P. G. 866
Verbenaceae	*Lantana camara* L.	P	K. C. 159
	Lippia gracilis Schauer	S	K. C. 69
Vitaceae	*Cissus decidua* Lombardi	P	P. G. 672
	Cissus simsiana Schult. & Schult. f.	P	K. C. 28
Vochysiaceae	*Callisthene microphylla* Warm.	P	P. G. 401

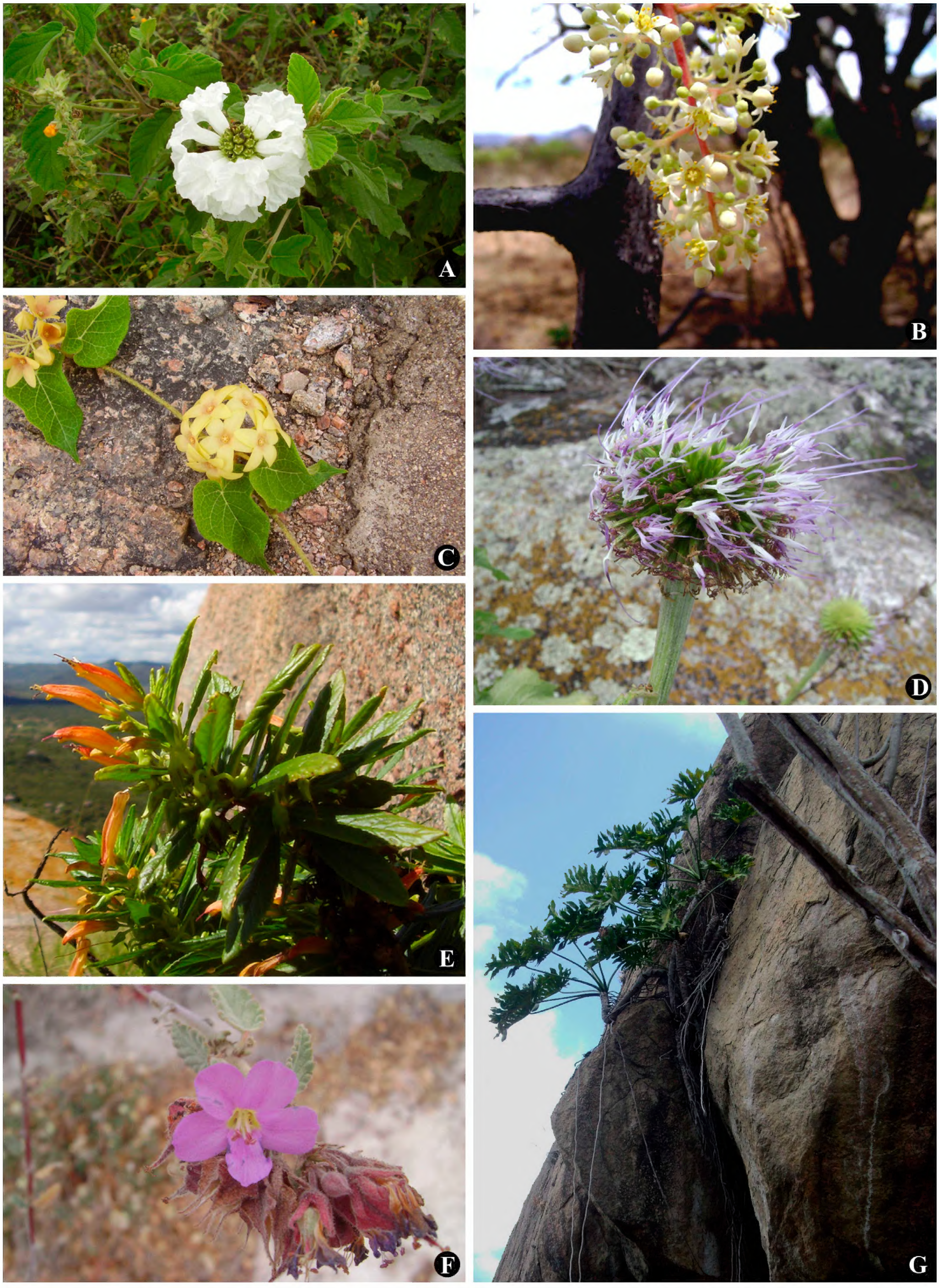

Figure 3. Some angiosperms species of the Parque Municipal Pedra Furada, NE – Brazil. A. *Cordia globosa* (Jacq.) Kunth (Boraginaceae); B. *Spondias tuberosa* Arruda (Anacardiaceae); C. G*onolobus cearensis* Malme (Apocynaceae); D. P*ithecoseris pacourinoides* Mart. ex DC. (Asteraceae); E. *Ameroglossum pernambucense* Fischer, Vogel & Lopes (Scrophulariaceae); F. *Melochia tomentosa* L. (Malvaceae); and G. *Philodendron bipinnatifidum* Schott ex Endl. (Araceae).

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